PRESS RELEASE

LOUISIANA UNIVERSITIES MARINE CONSORTIUM
July 28, 2013

Abstract

The 2013 area of low oxygen, commonly known as the ‘Dead Zone,’ measured 15,120 square kilometers (= 5,800 square miles) in this summer’s mapping expedition. Based on the May nitrogen load from the Mississippi River, the area was predicted to be 18,900 to 22,200 square kilometers (7,300 to 8,600 square miles), depending on the model. While not one of the larger areas mapped since systematic surveys started in 1985 by LUMCON and LSU researchers, the size of this year’s zone of oxygen-depleted bottom-water is above the long-term average and above the average size of the last five years.

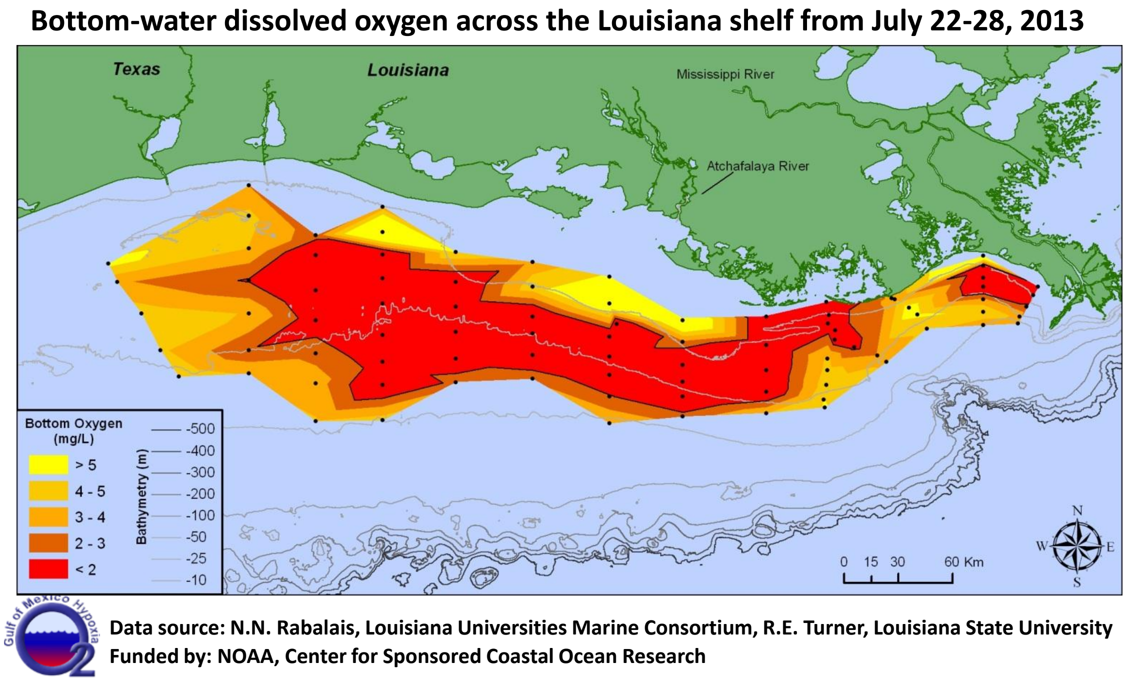
Hypoxia forms as a result of the nutrient-overloaded waters of the Mississippi River stimulating the excess growth of phytoplankton. Not all of the phytoplankton is consumed by higher levels of the food web, and it sinks to the seabed where bacteria decompose the remains and deplete the oxygen. The low oxygen forms in the lower half of a stratified water column (warmer, fresher water overlying cooler, saltier water), which keeps the plentiful oxygen in the surface waters from reaching into the lower layer and replenishing the oxygen depleted by the microbial activity.

The size, while large, was a result of mixed conditions on the southeastern part of the study area, and winds from the west pushing the hypoxic water mass towards the east and thus reducing the bottom area footprint. At stations where hypoxia was found, the values were extremely low and close to zero.

The 2013 area of low oxygen, commonly known as the ‘Dead Zone,’ measured 15,120 square kilometers (= 5,840 square miles) in this summer’s mapping expedition. Based on the May nitrogen load from the Mississippi River, the area was predicted to be 18,900 to 22,200 square kilometers (7,300 to 8,600 square miles), or one of the largest on record, since systematic mapping started in 1985 by LUMCON and LSU[1] researchers. The size of this year’s zone of oxygen-depleted bottom-water is remains large and above the long-term average and above the average size of the last five years.

Mixed conditions on the southeastern shelf (see below) diminished the likelihood of hypoxia during the early part of the cruise. For example, station C6C off Terrebonne Bay falls within the long-term frequency of 75% summertime hypoxia, but measured 4.8 mg/L on July 22. The cruise re-occupied transect C on July 28. The water column had settled down and the dissolved oxygen at station C6C was 1.5 mg/L. The total bottom area posted above takes these newer values into account, and the final map will be posted at http://www.gulfhypoxia.net.

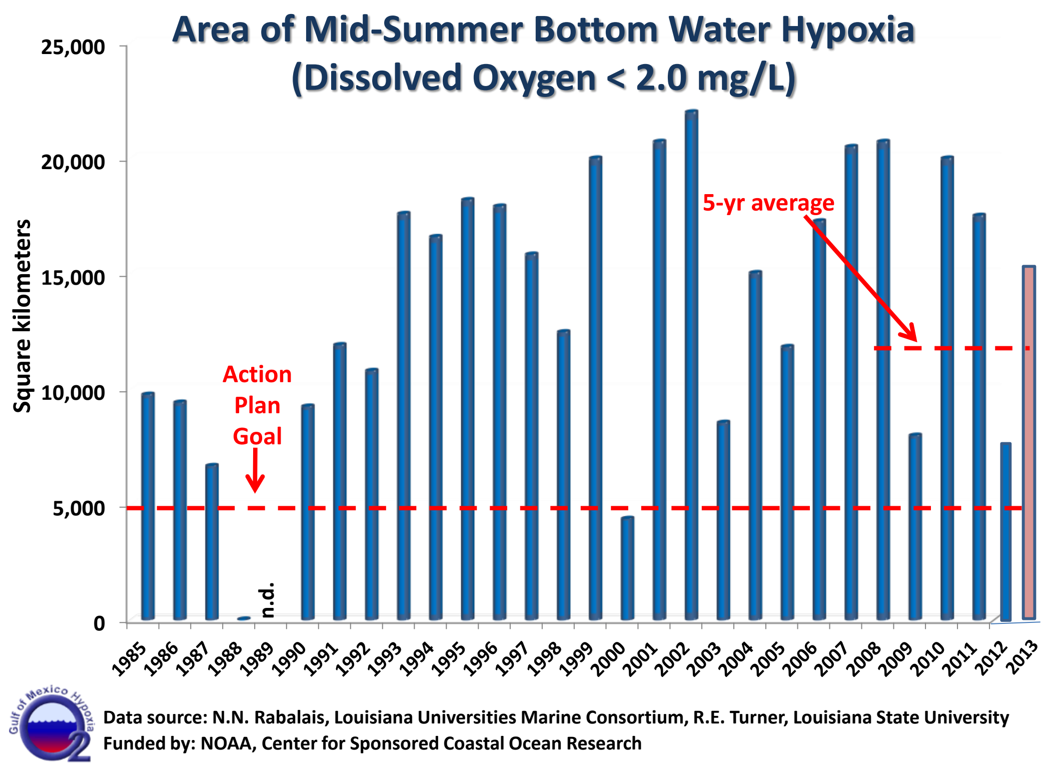
[1] Louisiana Universities Marine Consortium and Louisiana State University



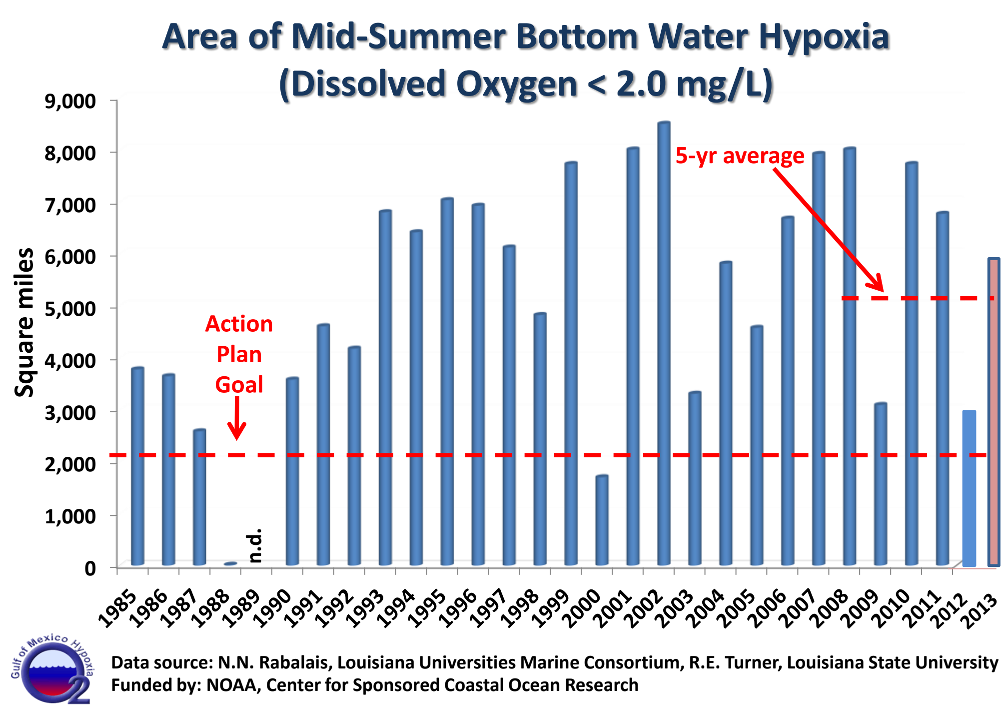
Distribution of the concentration of bottom-water dissolved oxygen along the Louisiana-Texas shelf, July 22-28, 2013. The dark line delineates the area where the dissolved oxygen is less than 2 milligrams per liter, or hypoxia.

The bottom area affected by hypoxia from this cruise are combined with data from 28 previous years to form the basis of the Mississippi River/Gulf of Mexico Nutrient Task Force Hypoxia Action Plan to reduce the size of the low oxygen area to 5,000 square kilometers (about 1,930 square miles) over a five-year running average. Both the five-year average and the Hypoxia Action Plan goal are depicted in the bar chart below.

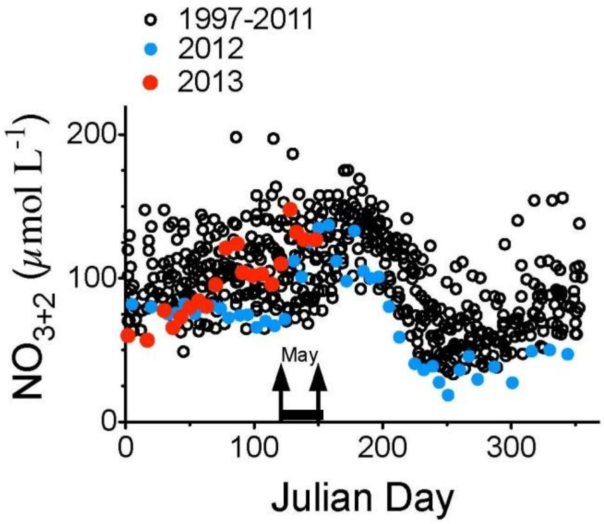
Above average Mississippi River discharge in mid-May to the end of July in 2013 followed a record drought across the Mississippi River Basin in 2012. The concentration of nitrate-nitrogen in the Mississippi River at Baton Rouge was above average in May through March. This increase is most likely related to the flushing of nutrients from the landscape following a year of drought without much rain. The flow of the river also increased through the March through May period so that a large total load (discharge × concentration) resulted. The average May nitrogen load, as determined by the U.S. Geological Survey, was 7,316 metric tons per day. The two models that have fairly accurately predicted the size of the summer hypoxia based on May nitrogen loads resulted in a large predicted size.



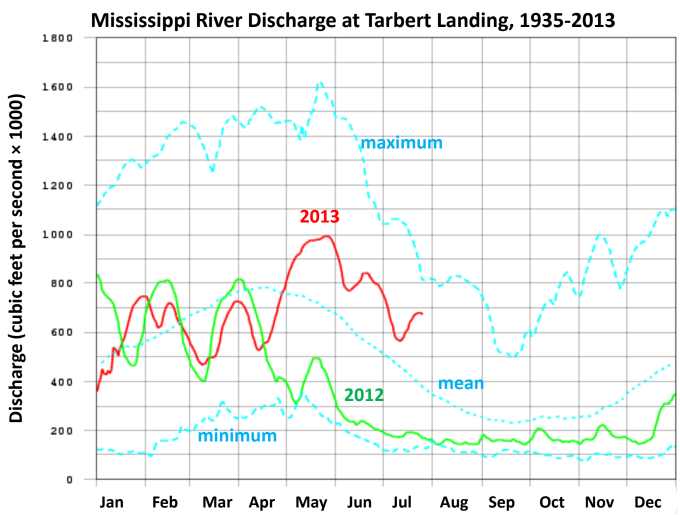
Bottom-water hypoxia area estimates from 1985-2013. Although some mapping was conducted in 1989, the complete survey was not conducted, no data (n.d.). The five-year running average and goal for the Hypoxia Action Plan are represented by the horizontal lines.



Same bottom-water hypoxia area estimates from 1985-2013 in square miles.



Nitrate (+nitrite) concentration in the Mississippi River at Baton Rouge, Louisiana, from 1997 to present with the month of May highlighted. Data source: R. Eugene Turner, LSU.



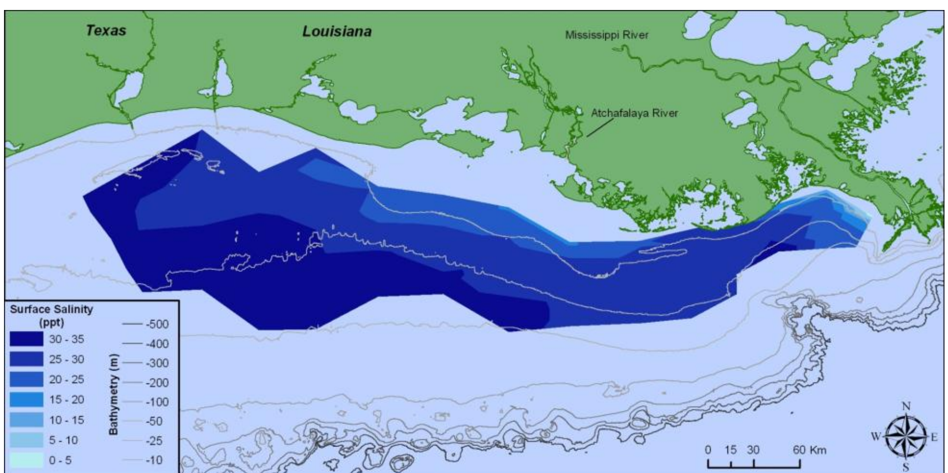
Flow of the Mississippi River at Tarbert Landing since 1935 with discharge for 2013 in red, compared to long-term conditions (http://www2.mvn.usace.army.mil/eng/edhd/tar.gif).

Two processes—one physical and one biological—are necessary conditions for the formation of hypoxia in the spring and summer. The physical conditions depend on the freshwater discharge of the Mississippi River, which forms a lower salinity water column over a saltier water column. As the season progresses, heating from the sun decreases the density (weight) of the fresher waters compared to the cooler (denser) waters below. A strong gradient(s) form in the water column from surface to bottom. The natural movement of oxygen from the surface to the bottom is impaired by the presence of this gradient difference (the pycnocline). Also, as the spring progresses into summer, freshwater and nutrient loads increase in the outflows of the river delivered through the main stem Mississippi River south of New Orleans and a second delta at the Atchafalaya River (carries about one-third of the total river discharge) mid-coast. Other factors affecting this physical structure are weather events, wind-driven currents, and tropical storms and hurricanes. These processes can mix the water column or shift the mass of hypoxic water or both.

The nutrients—nitrogen, phosphorus and silica—are important for the growth of microscopic plants called phytoplankton. Increases in the loads of nutrients stimulate high production by the phytoplankton. Much of the phytoplankton is consumed by zooplankton that support a rich food web, but their byproducts in the form of fecal pellets sink to the bottom. Some of the phytoplankton die and sink directly to the bottom. The result is high loading of organic matter. Bacteria that live in the lower water column and in the sediments consume the organic matter and in the process use up oxygen. The oxygen is consumed by the bacteria faster than the oxygen can move from the surface to the bottom, especially with multiple gradients impeding the movement. The result is a lower water column depleted of oxygen.

There was a considerable amount of fresh water from the Mississippi and Atchafalaya rivers on the Louisiana continental shelf. The instruments lowered through the water column that electronically collect data on salinity, temperature, dissolved oxygen, turbidity, phytoplankton biomass and light penetration show much lower salinity in much of the surface waters.

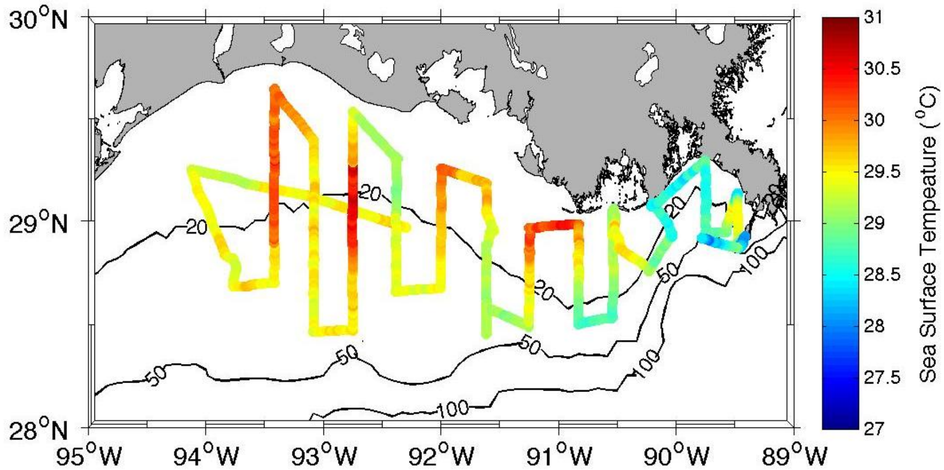
Surface-water salinity across the Louisiana shelf from July 22-27, 2013.



Data source: N.N. Rabalais, Louisiana Universities Marine Consortium, R.E. Turner, Louisiana State University
Funded by: NOAA, Center for Sponsored Coastal Ocean Research

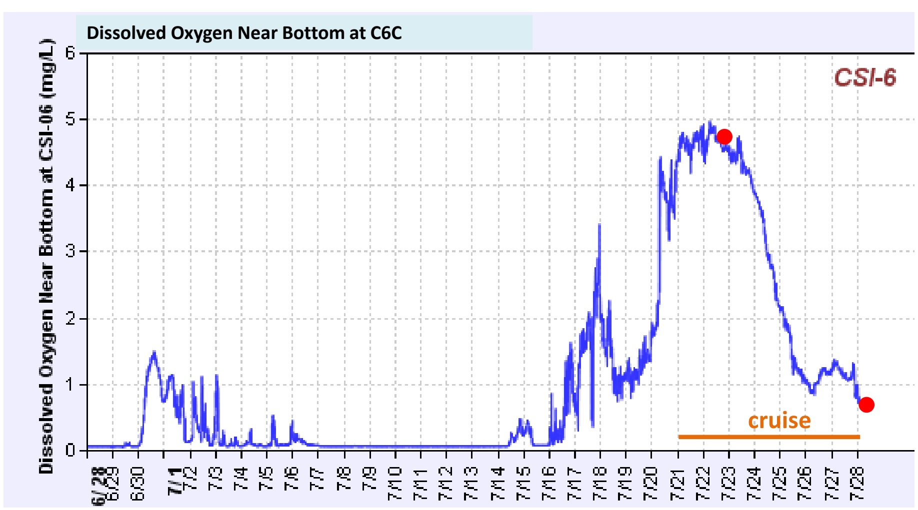
Distribution of the surface salinity along the Louisiana-Texas shelf, July 22-27, 2013.

Surface temperatures in the northern Gulf in mid-July are usually about 30 °C, but were mostly 29 °C in the 2013 survey. Surface temperature is usually warmer than the underlying waters, which contributes to the strength of the gradients across the water column. There is also usually a steep decline in temperature in the lower water column which corresponds to the oxycline, greatest decrease in oxygen within a narrow depth range. There was evidence of mixing of the water column in the area of transects B, C and D' with water temperature profiles indicating thermal inversion due to mixing. [Note: bluer colors in surface temperature.] In these cases the surface temperature was warm, decreased with depth, then increased in deeper waters to the surface temperature, then declined again to the bottom. Other lines of evidence indicate that the wind speed was high during the two weeks before the cruise and calm during early to mid-July.

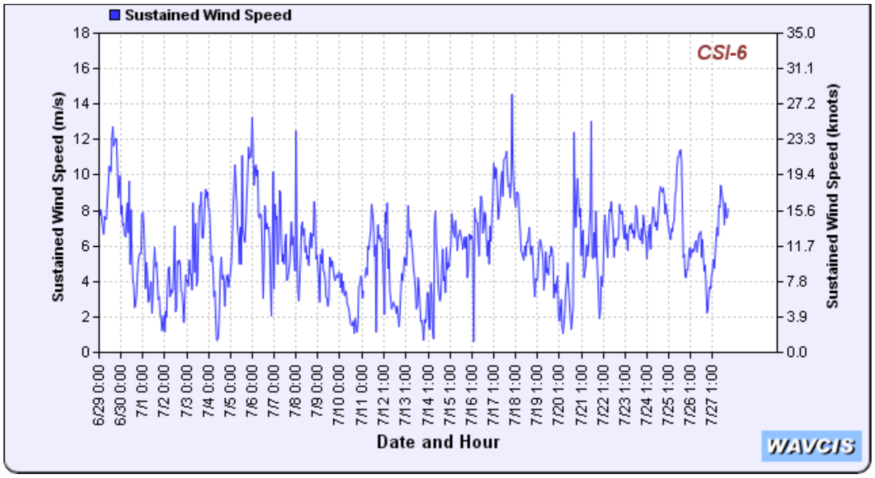


Surface Water Temperature from Southwest Pass to Galveston Bay, 21-27 July 2013, source: Xinping Hu, Texas A&M Univ, Corpus Christi.

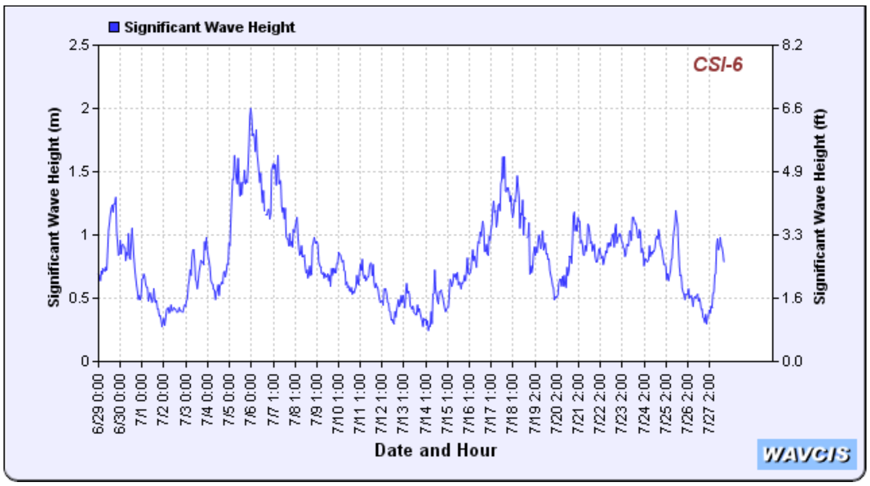
Bottom-water dissolved oxygen concentrations at station C6C in 20 m depth along transect C were well below 2 mg/L and close to zero until wind speed and wave heights increased mid-July from weather systems along the coast. Mixing events can rapidly break down the density structure of the water column and mix high oxygen surface waters with low oxygen bottom waters. After a return of the stratification, it takes some time for the oxygen consumption by the bacteria to again reduce the oxygen levels in the lower part of the water column. Similar mixing will occur during tropical storms and hurricanes depending on their size, speed and trajectory through the area of hypoxia. As the survey cruise moved further west, more typical summertime stratification replaced the mixed water columns beginning with transect D, and lower water column water dissolved oxygen conditions approached zero at many stations. The nearshore stations were well-mixed with well-oxygenated waters from surface to bottom. The bottom hypoxic water mass was farther offshore in water depths of 10 to 35 m.



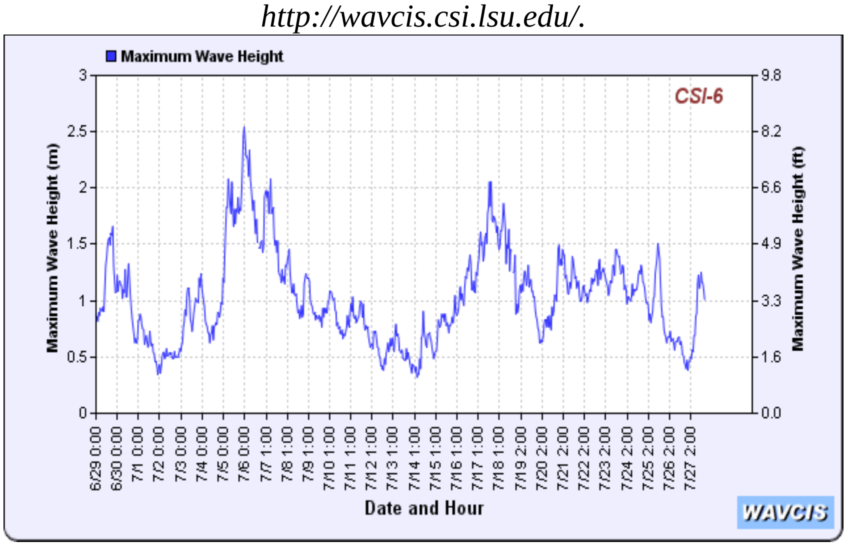
Continuous dissolved oxygen concentrations near bottom at station C6C for July with the period of the hypoxia survey cruise indicated. Station C6C was 4.8 mg/L in the earlier part of the cruise and 0.7 mg/L at the end (red dots). Data source: Nancy N. Rabalais, LUMCON, WAVCIS/BIO2.



Sustained wind speed at station C6C for July. Data source: LSU WAVCIS, http://wavcis.csi.lsu.edu/.

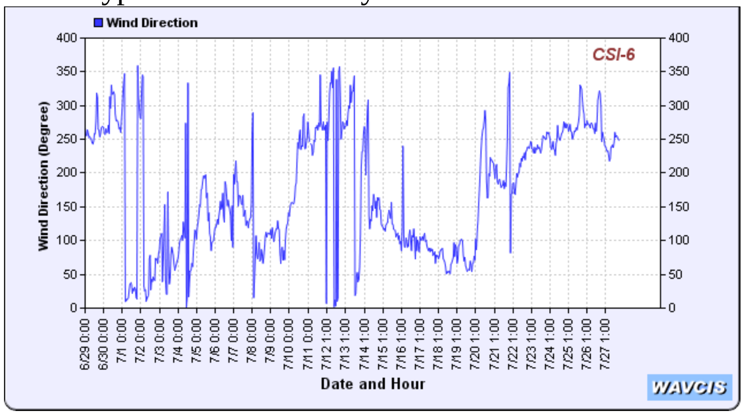


Significant wave height at station C6C for July. Data source: LSU WAVCIS, http://wavcis.csi.lsu.edu/.



Significant wave height at station C6C for July. Data source: LSU WAVCIS, http://wavcis.csi.lsu.edu/.

Another factor that might reduce the bottom area footprint is winds from the west (270° ± 45°) that would push the hypoxic water mass to the east. There was evidence that this had occurred because the bottom-water hypoxia extended only to transect K and not further west.



Wind direction at station C6C for July. Data source: LSU WAVCIS, http://wavcis.csi.lsu.edu/.

Hypoxia is a recurring environmental problem in Louisiana (and sometimes Texas and Mississippi) offshore waters. Considerable effort to decrease the nutrient loading to the Mississippi River is required to reverse the widespread occurrence of hypoxia.

The missing oxygen affects the behavior and mortality of animals living in the Gulf. Those that can swim away from oxygen levels less than 2 mg/L (2 ppm) can escape the suffocating conditions. However, this means that 14,000 square kilometers of Gulf bottom off Louisiana is unsuitable habitat for penaeid shrimp and demersal fishes, such as red drum, red snapper, croaker, and many others. Stressed benthic (seabed) dwellers were often sighted in the surface waters when the water below was severely depleted in oxygen. These animals included benthic burrowing eels, lesser blue crabs (*Callinectes similis*), small blue crabs (*C. sapidus*) and another swimming crab (*Portunus gibbesii*). Animals that cannot swim away because they live in the sediments eventually die as the oxygen falls below the level necessary to keep them alive. These animals are the crabs, starfish, brittle crabs, worms, small burrowing shrimp and many worms. Their demise eventually affects the quality of food available to fish that return to the area in the fall after hypoxia has abated. Further, low oxygen conditions have been show to affect the reproductive capacity of demersal fishes such as Atlantic croaker.

For further information, contact:
Dr. Nancy Rabalais, nrabalais@lumcon.edu, or
Dr. Gene Turner, euturne@lsu.edu

Visit the Gulf Hypoxia web site at http://www.gulfhypoxia.net for maps, figures, additional graphics and more information concerning this summer's research cruise, and previous cruises.

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